OCCUPATIONAL RADIATION MONITORING AND QUALITY ASSURANCE IN HOSPITAL X-RAY DEPARTMENTS

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ABSTRACT

Quality assurance is essential to any programme of diagnostic radiology, to prevent undue exposure of x-ray personnel and patients to radiation.

This paper reports observations from a survey of some hospital x-ray facilities in Accra and Kumasi in Ghana, to find out about steps taken by x-ray workers to ensure quality control and administration in diagnostic radiology.

The grid point method has been used to do a detailed study of scatter radiation levels of two x-ray departments in Accra.

The iso-dose rate contours have been analysed, and results show the importance of good design of x-ray rooms and provision of protective structures.

KEYWORDS diagnostic radiology, quality assurance, shielding, workload, radioprotection

INTRODUCTION

The quality of a radiographic film is rated on the information it supplies about all potentially visible anatomical structures and all abnormal details, with adequate contrast.

In Ghana, the greatest contributory factor to man-made radiation exposure is due to x-rays. It is estimated that diagnostic x-ray machines contribute about 90% of man-made radiations. Therefore it is important to establish a reliable and effective quality assurance programme and good radiation monitoring techniques to minimise the exposure due to medical x-ray examinations, [1, 2, 3, 4,].

A survey was conducted in two regions in Ghana:- the Greater Accra Region and the Ashanti Region - to study the quality assurance measures available and to establish the radioprotection problems in the country.

We report observations from this survey and present iso-dose rate contours from the study of the scatter radiation levels of two x-ray departments in Accra.

SURVEY

Questionnaire were circulated to sixteen hospitals in Greater Accra and Ashanti regions of Ghana (Table 1). Two of the hospitals in Greater Accra region were selected for detailed study of scatter radiation levels and evaluation of the level of safety with respect to the design of the x-ray facility, using the grid point method [6]. The two hospitals are:- 37 Military Hospital and University of Ghana Hospital.

Table 1: Type of X-ray Unit, Equipment(s) and Their Use

Table 1:1 X-ray Units in Kumasi, Ashanti Region.

Name of X-ray unit	Type of X-ray equipment	Equipment Age (years)	Country of origin	Type of hospital
Bantama Clinic	TUR D 36	4.50	G.D.R.	Private
Adum Clinic	Pleodor 3	18.00	West Germany	Private
Komfo Anokye Teaching Hospital	TUR DE 38 TUR D 701 TUR D 701	5.00 1.50 6.00	G.D.R. G.D.R. G.D.R.	Public
Komfo Anokye Polyclinic	Tridoros (Siemes) 512 MP TUR DE 38	5.00 8.00	West Germany G.D.R.	Public
U.S.T. Hospital	Watson MX2	14.00	U.K.	University

Table 1.2: X-ray Units in Accra, Greater Accra Region.

Name of X-ray unit	Type of X-ray equipment	Equipment Age (years)	Country of origin	Type of hospital
37 Military Hospital	TUR DE 38 TUR D 701 Watson Roentgen 501	8.00 3.00 2.00	G.D.R. G.D.R. U.K.	Military
Police Hospital	Watson MX4 TUR D 703	13.00 0.25	U.K. G.D.R.	Police
Princes Marie Louise Hospital	Watson MX2	14.00	U.K.	Children
University of Ghana Hospital	Watson MX2	14.00	U.K.	University
Faith Evangelical Mission Clinic	Selemat 500	20.00	Italian	Private
Ridge Hospital	TUR D 701	3.00	G.D.R.	Public
Korle Bu Teaching Hospital	TUR D 701	3.00	G.D.R.	Public
Kumoji Hospital	Watson MX2	14.00	U.K.	Private
Mamprobi Polyclinic	Watson MX4 Hitachi	13.00 10.00	U.K. Japan	Public
Adabraka Polyclinic	TUR DE 38	8.00	G.D.R.	Public
G.N.T.C. Clinic	Watson MX4	13.00	U.K.	Private

The questionnaire dealt with:-

1. quality control routine determination of physical parameters of the various components of the x-ray imaging system, and

2. quality administration for managing the procedures of the quality control and possible corrective actions.

Six most frequent diagnostic examinations were covered:- Chest, Extremeties, Skull, Spine, Pelvis and Abdomen. The type of x-ray unit, equipment(s), and their use are given in Table 1.

RESULTS

1. PERSONNEL AND EQUIPMENT

The calibre of personnel determines the commitment of any establishment to effective quality assurance measures. Table 2 describes the qualifications of the highest ranking Technical x-ray personnel in the hospitals under study.

Table 2: Qualifications of the Highest Ranking X-ray Personnel in the Various Hospitals.

Rank	Chief Radiographer	Principal X-ray Technician	Technician
Number of Hospitals	5	8	3

Ideally, all radiography machines should be fixed in position. Mobile machines should have adequate output to keep short the exposure time and must be fitted with an accurate optical localizer [5]. Figure 1 summerizes the number of fixed and mobile x-ray machines.

None of the mobile x-ray machines are used in a hospital ward.

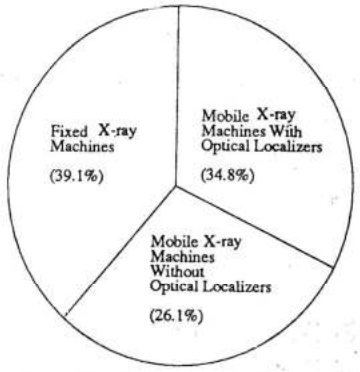

Figure 1: Operational Procedures of X-ray Equipments.

Details about routine equipment maintenance are given in Table 3. The equipment condition affects the quality of the x-ray film. Our survey showed that regular maintenance and servicing of equipment depend on the size of the hospital and local possibilities, such as spare parts, training of personnel, etc.

The two establishments which service most of the x-ray equipment in Ghana are the Interassociates Ghana Limited and X-ray Technical Division, Korle Bu Teaching Hospital, Accra.

For saftey and for maximum working efficiency, the x-ray room must have lead glass window in the protective screen. Mobile protective screens must be placed at the prescribed manufacturers distance (usually more than 2.0

Table 3: Number of Hospitals and Frequency of Servicing Their Machine(s).

Frequency of service	Every four months	Every six months	Once a year	Only upon request
Number of hospitals	3	2	2	9

m) away from the x-ray tube. The film hatch to the darkroom must be easily reached. Table 4 illustrates the design of protective screens and handling of film.

Table 4: Design of protective Screens and the Presence of Film Hatch in the Various X-ray units.

		Number of X-ray unit (s)
Fixed Protective Screen		9
Mobile Protective Screen		10
Both Fixed and Mobile Protective Screen		2
Fixed Protective Screen with lead glass		7
Distance Between X-ray Tube and Mobile Protective Screen	More Than 2.0m	9
	Less Than 2.0m	3
No Protective Screen		1
Film Hatch		4

2. SHIELDING AND FILM PROCESSING

The structural shielding requirements of an x-ray room depends on the output parameters of the x-ray machine. For an ideal x-ray room, the expected percentage of workload should be as follows:- 50.0% for Chest examinations, 30.0% for Abdomen, Pelvis and Spine Column examinations, and 20.0% for Skull and Extremeties examinations [5]. On the average, the percentage of workload identified in the survey were: Chest examination :- 33.12%, Abdomen, Pelvis and Spine Column Examinations:- 30.15%, Skull and Extremeties examinations:- 36.73%, with a full occupancy in the supervised area. Details of the design of walls, doors, windows, and film processing conditions are listed in Table 5.

The types of medium contrast films identified were:- Agfa-Gevaert, Kodak, ORWO, Ilford, Unimex, Curix, 3M(XMB), G 2301, and Wicor-XRP films.

Table 5: Design of Walls, Doors and Windows of X-ray Rooms, and Film Processing Conditions.

		Number of hospital(s)
Concrete Incorporated with Barium Salt or lead, in all the Walls		7
Ordinary Walls		9
Provision Made in Walls for Positional Change and / or Installment of New X-ray Machine		6
Lead-lined Doors and Windows		7
Film Processing Condition	Manual	15
	Automatic	1
Air-conditioned or Well Ventilated Darkroom		7
Warning Light(s) (In front of X-ray Room(s))		1

Table 6: Operational Parameters for Various X-ray Machines Identified in Two Hospitals in Accra.

Table 6:1: Watson MX4 X-ray Machine, University of Ghana Hospital

Type of Examination	KV	mAs	F.F.D (m)	Workload (mA-min/week)
Chest X-ray (Standing)	78	40	1.57	7.0
Chest X-ray (Table Top)	74	25	1.14	1.3
Cervical Spine	78	50	1.12	2.5
Lumber Spine	88	200	1.12	10.0
Extremeties	70	15	1.12	1.6

Table 6.2: TUR DE 38 X-ray Machine, X-ray Room 1, 37 Military Hospital, Accra

Type of Examination	KV	mAs	F.F.D. (m)	Workload (mA-min/week)
Chest X-ray (Standing)	70	9	1.83	1.3
Cervical Spine	80	20	0.93	0.7
Skull	90	20	0.93	1.7
Extremeties	56	2	0.93	0.5

Table 6:3 : TUR D 701 X-ray Machine, X-ray Room 2, 37 Military Hospital, Accra

Type of Examination	KV	mAs	F.F.D. (m)	Workload (mA-min/week)
Chest X-Ray (Standing)	70	9	1.83	18.4
Cervical Spine	80	50	0.93	10.7
Skull	70	30	0.90	3.8
Abdomen	80	40	1.00	20.0
Pelvis	80	30	1.00	8.9
Extremeties	45-50	40	0.90	4.3

The operational parameters used to evaluated the level of safety of the two x-ray facilities under study, are shown in Table 6. Figures 2a and 2b give the general layout of the two hospitals. Figures 3a and 3b show the grid point method in two x-ray units, for the detailed study of scatter radiation levels, and figures 4-11, show the iso-dose rate contours for some of the specified examinations in the two hospitals.

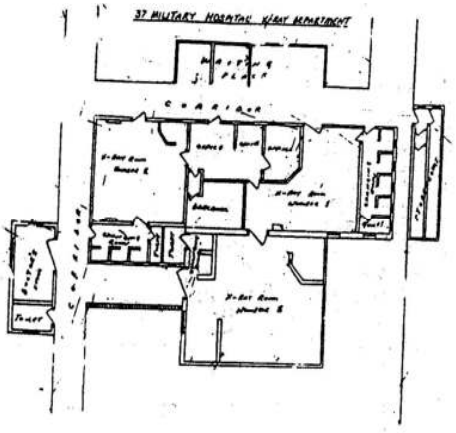

Fig. 2a: General Layout, X-ray Department 37 Military Hospital, Accra

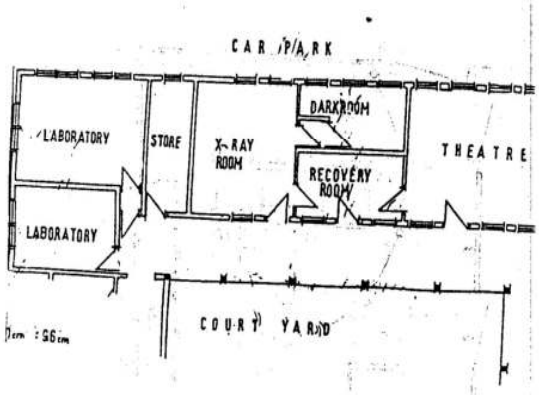

Fig. 3a: General Layout, X-ray Department University of Ghana Hospital, Accra

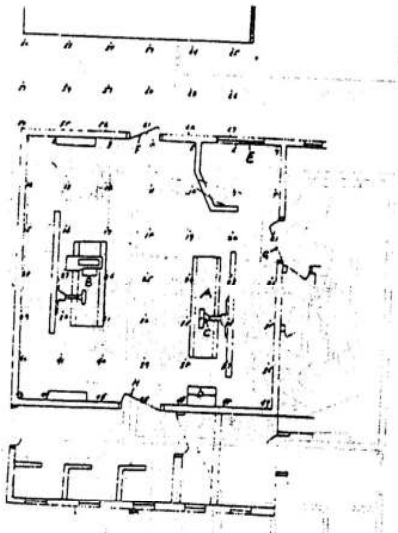

Fig. 3b: Arid Point Survey (X-ray Room 2) 37 Military Hospital, Accra

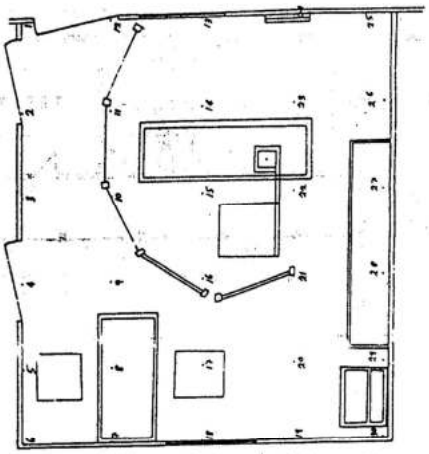

Fig. 3c: Arid Point Survey, X-ray Department, University of Ghana Hospital, Accra

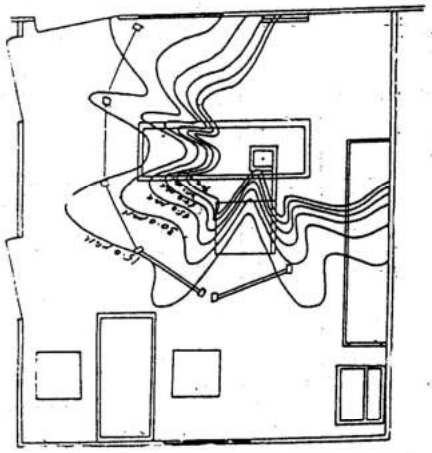

Fig. 5: Chest X-ray (Table top) Examination

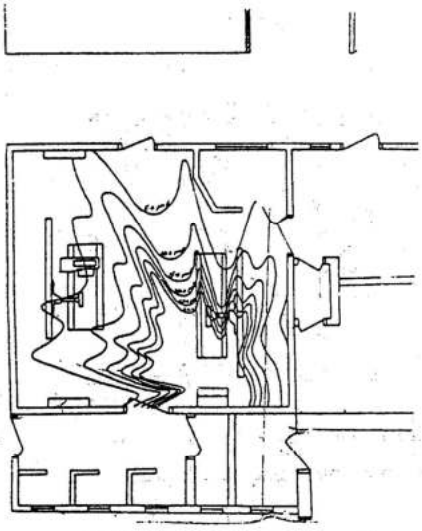

Fig. 4: Chest X-ray (Standing) Examination

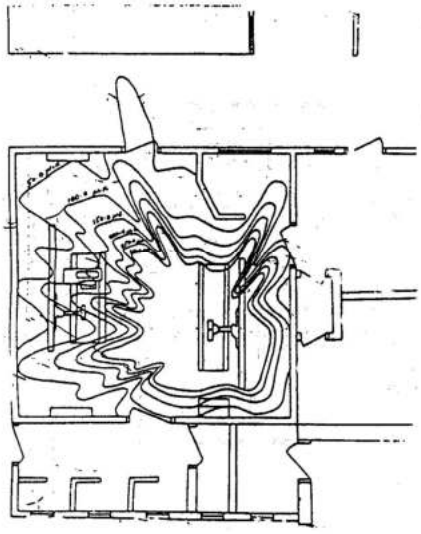

Fig.6: Cervical Spine Examination

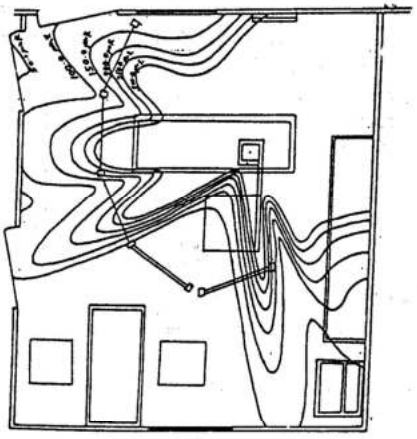

Fig. 7: Lumber Spine Examination

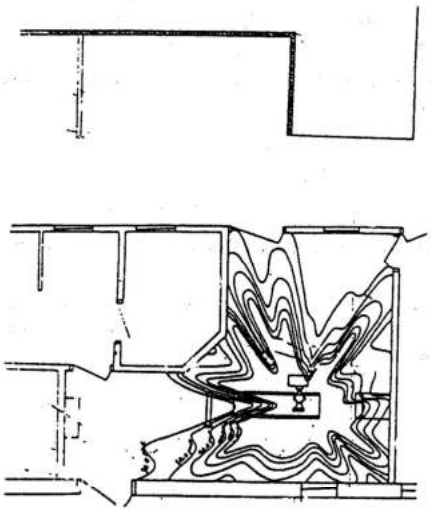

Fig. 8: Skull Examination

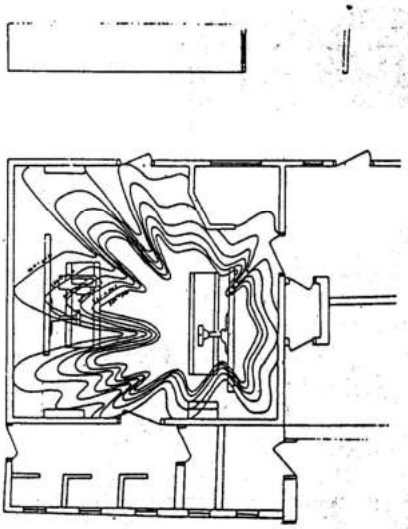

Fig. 9: Abdomen Examination

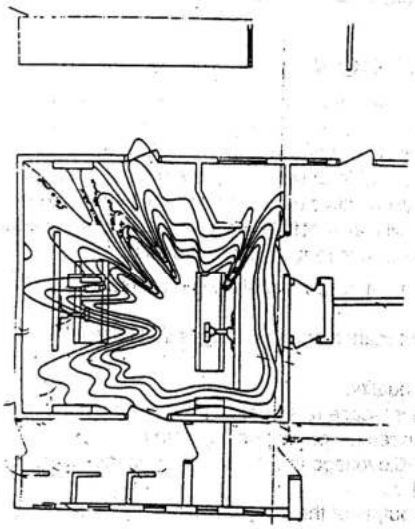

Fig. 10: Pelvis Examination

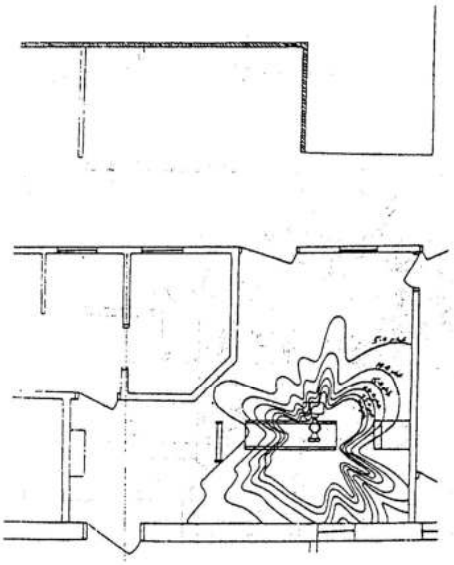

Fig. 11: Extremeties Examination

DISCUSSION

The survey showed that in many x-ray Departments in the small hospitals, the highest ranking officer was of the level of a Technician. Well qualified Radiographers are to be found in only the big government hospitals. In many small hospitals the x-ray units are being manned by personnel who are not fully knowledgeable about essential quality assurance requirements such as:-

1. minimum occupational and patient exposure
2. maintenance and servicing of equipment, and
3. film quality.

The iso-dose rate contours (figs 4-11), depend on:-

i. the direction of the primary beam
ii. the Kilovoltage and mAs technique factors used, and
iii. the output of the x-ray machine.

The range of dose rate varied proportionally to the size of Kilovoltage and mAs technique factors used for the diagnostic examinations [6].

Full occupancy in supervised area was observed in each of the x-ray units under the survey. This is typically shown in the distributions of dose rate levels in the Cervical Spine and Pelvis examinations (both in x-ray room 2). Scatter radiation was detected on the corridor, in front of the x-ray rooms, and in parts of patient's waiting area, for all examinations. This is due to the absence of lead-lined entrance door.

CONCLUSION

The survey revealed the importance of quality assurance programme on the safety and design of an x-ray Department, by taking into account:-

i. the type of x-ray equipment to be installed
ii. the education and experience of personnel
iii. the equipment condition
iv. the type of routine and special examinations to be undertaken and their workloads
v. the technique factors to be employed, and
vi. the radioprotection and dosimetric approach.

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